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CALSPAN ON-SITE ROLLOVER CRASH INVESTIGATION
SCI CASE NO.: CA09077

VEHICLE: 2007 CHRYSLER ASPEN LIMITED

LOCATION: NORTH CAROLINA

CRASH DATE: OCTOBER 2009

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The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points are coupled with the investigator's expert knowledge and experience of vehicle dynamics and occupant kinematics in order to determine the pre-crash, crash, and post-crash movements of involved vehicles and occupants.

Because each crash is a unique sequence of events, generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicle(s) or their safety systems.

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16. Abstract This on-site investigation focused on the rollover crash of a 2007 Chrysler Aspen Limited. The Chrysler was equipped with four-wheel anti-lock brakes, Electronic Stability Control (ESC), a Certified Advanced 208-Compliant (CAC) frontal air bag system, and side impact Inflatable Curtain (IC) air bags with rollover sensing. The manufacturer of the Chrysler Aspen has certified that the vehicle was compliant to the advanced air bag portion of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The CAC system included dual-stage frontal air bags for the driver and front right passenger positions, seat track positioning sensors, safety belt buckle switch sensors, retractor pretensioners, and a front right occupant presence sensor. The Chrysler departed the roadway to the right while negotiating a curve to the left, rotated counterclockwise, and initiated a rollover event to the right. The IC air bags on both sides deployed. The 26-year-old female driver sustained police reported severe injuries. A 10-month-old male passenger was secured in a Child Restraint System (CRS) in the rear center seating position. He sustained police reported possible injuries. The driver and passenger were transported by ambulance to a regional hospital for treatment.			
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BACKGROUND

This on-site investigation focused on the rollover crash of a 2007 Chrysler Aspen Limited **(Figure 1)**. The Chrysler was equipped with four-wheel anti-lock brakes, Electronic Stability Control (ESC), a Certified Advanced 208-Compliant (CAC) frontal air bag system, and side impact Inflatable Curtain (IC) air bags with rollover sensing. The manufacturer of the Chrysler Aspen has certified that the vehicle was compliant to the advanced air bag portion of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The CAC system included dual-stage frontal air bags for the driver and front right passenger positions, seat track positioning sensors, safety belt buckle switch sensors, retractor pretensioners, and a front right occupant presence sensor. The Chrysler departed the roadway to the right while negotiating a curve to the left, rotated counterclockwise, and initiated a rollover event to the right. The IC air bags on both sides deployed. The 26-year-old female driver sustained police reported severe injuries. A 10-month-old male passenger was secured in a Child Restraint System (CRS) in the rear center seating position. He sustained police reported possible injuries. The driver and passenger were transported by ambulance to a regional hospital for treatment.

Figure 1: Front left view of the 2007 Chrysler Aspen.

The vehicle was identified through a visit to a regional vehicle salvage facility on November 9, 2009. Based on the rollover of the vehicle and the deployment of the IC air bags, this case was assigned for an on-site investigation on November 10, 2009. The on-site investigation was initiated on November 11, 2009. The investigation involved the inspection and documentation of the Chrysler, and the documentation of the crash site. The driver was not available to be interviewed. An attempt was made to image the Event Data Recorder (EDR) of the Chrysler during the inspection; however, this crash sequence did not include a frontal event and no data was stored in the EDR. The medical records were not obtained from the hospital despite multiple requests.

SUMMARY

Crash Site

This crash occurred during the daylight hours of October 2009 on a two-lane north/south rural roadway that curved to the left. The environmental conditions were dry and clear at the time of the crash. The roadway consisted of two asphalt surfaced travel lanes that measured 3.2 m (10.5 ft) in width. The roadway was bordered by narrow asphalt shoulders. The west shoulder was 60 cm (23.6 in) in width and the east shoulder was 90 cm (35.4 in) in width. The grass roadsides contained embankments that sloped away

from the roadway and extended outboard of the shoulders. The embankment on the west roadside began at the road edge and extended west 1.7 m (5.6 ft) with a negative grade of -3.2 percent. Beyond this embankment was a ditch that measured 3.4 m (11.2 ft) in width and had a negative grade of -32 percent entering the ditch on the east side and a positive grade of 59 percent exiting the ditch on the west side. In the pre-crash area, the roadway had a level grade. The grade transitioned to a negative grade of -1.6 percent near the site of the rollover. The pre-crash area also included a curve to the left with a radius of curvature of 337 m (1,105 ft). The curved section of roadway also included a superelevation of -1.6 percent from west to east. At the site of the rollover was an intersecting roadway that extended west from the north-south roadway. On the southwest corner of this intersection was a residential yard and a stop sign mounted on a 7.6 cm (3 in) square wood post. The posted speed limit in the area was 89 km/h (55 mph). The schematics of this crash are included as **Figures 8** and **9** of this report.

Vehicle Data – 2007 Chrysler Aspen

The case vehicle was a 2007 Chrysler Aspen Limited. The Chrysler was manufactured in May of 2007 and was identified by the Vehicle Identification Number (VIN): 1A8HX58P77F (production sequence deleted). The odometer reading at the time of the crash was 58,086 km (36,093 mi).

The rear-wheel drive Chrysler was powered by a 4.7-liter, V-8 flex fuel engine linked to a 5-speed automatic transmission. The braking system consisted of front and rear disc brakes with four-wheel anti-lock and electronic brake force distribution. The Chrysler was also equipped with Electronic Stability Control (ESC) and an indirect Tire Pressure Monitoring System (TPMS). The side windows were closed at the time of the crash. The Chrysler was equipped with three Goodyear Wrangler SR-A tires sized at P265/60R18. The left front wheel was separated in the crash and was not available for inspection. The manufacturer recommended tire size was P265/60R18. The tires were mounted on OEM seven-spoke alloy wheels. The manufacturer recommended cold tire pressure was 228 kPa (33 PSI), front and rear. The specific tire data at the time of the SCI inspection was as follows:

Position	Measured Tire Pressure	Measured Tread Depth	Damage
Left Front	Unknown	Unknown	Unknown, wheel and tire separated from the vehicle
Left Rear	Tire flat	6 mm (8/32 in)	None, de-beaded
Right Rear	214 kPa (31 PSI)	6 mm (8/32 in)	None
Right Front	214 kPa (31 PSI)	6 mm (7/32 in)	None, grass in bead of wheel

The interior of the Chrysler was configured with leather-surfaced eight-passenger seating. The front bucket seats were separated by a center console and equipped with adjustable head restraints. The front head restraints were in the full-down position. The front left

seat track was adjusted 8 cm (3.1 in) forward of the full-rear position. The front right seat track was in the full-rear position. The front left seatback angle was measured at 23 degrees aft of vertical. The front right seatback angle was measured at 25 degrees aft of vertical. The second row consisted of a split bench seat with folding backs and cushions that pivoted forward on the front attachment points to allow the seat to fold and tumble forward to create additional rear cargo space if needed. The second row adjustable head restraints were in the full-down positions. The second row seat tracks were not adjustable. The second row seatbacks were both adjusted to 21 degrees aft of vertical. The third row consisted of a single bench seat with a folding back that contained three seating positions. All three seats included adjustable head restraints that were in the full-down positions.

The interior safety systems consisted of 3-point lap and shoulder belt systems for the eight designated seating positions, front seat safety belt retractor pretensioners, dual-stage frontal air bags, and Inflatable Curtain (IC) air bags that provide protection for the six outboard seating positions. The Chrysler was equipped with rollover sensing for the IC air bags.

Crash Sequence

Pre-crash

The restrained 26-year-old female driver of the Chrysler was operating the vehicle southbound in a curve to the left at a police estimated speed of 89 km/h (55 mph). **Figure 2** depicts the Chrysler's pre-crash trajectory. The Chrysler departed the roadway to the right and traveled off-road for approximately 105 m (345 ft) in a tracking attitude. As the west side of the embankment exiting the ditch on the west roadside began to gain height, the Chrysler initiated a counterclockwise (CCW) yaw. The vehicle yawed approximately 90 degrees CCW and traveled out of the ditch as the ditch turned right prior to an intersecting roadway. The right tires of the Chrysler furrowed into the soft dirt and grass of the roadside. Although equipped with ESC, the irregular off-road surfaces limited the effectiveness of the system.

Figure 3: Pre-crash trajectory of the Chrysler.

Figure 2: Location of the start of the rollover.

Crash

The tires furrowing into the soil on the roadside tripped the Chrysler into a right side leading rollover prior to the vehicle crossing the intersecting roadway. **Figure 3** depicts

the location of the rollover. Based on evidence at the scene and the damage to the vehicle, the Chrysler rolled four-quarter turns over a distance of 23 m (75 ft). The vehicle traveled across the asphalt roadway, creating a group of six gouge marks near the roadside and two individual gouge marks near the center of the roadway as it rolled. The undercarriage of the Chrysler impacted the stop sign on the wooden post, fracturing the post. The Chrysler came to rest on its wheels facing in an easterly direction on the grass roadside at the southwest corner of the intersection.

Post-Crash

Police, emergency medical and tow personnel responded to the crash site. The driver of the Chrysler sustained police reported severe injuries and was transported from the scene by ground ambulance to a regional hospital. The rear center passenger sustained police reported possible injuries and was transported by ground ambulance to the regional hospital. The Chrysler was towed from the scene due to disabling damage. It was transferred to a regional vehicle salvage facility, where it was inspected for this investigation.

2007 Chrysler Aspen

Exterior

The exterior of the Chrysler sustained moderate damage to the left, top and right planes as a result of the rollover event. The windshield was 100 percent fractured; however, the laminate was intact. The left front, left rear door glazing and left and right rear glazing adjacent to the third row disintegrated as a result of the rollover. The right front, right rear door glazing and quarter glass, and the left rear door quarter glass were not damaged in the crash. The scratches on the roof were oriented laterally and in one direction only, indicating the vehicle had rolled over the roof only one time during the event. The direct contact to the roof extended 117 cm (46.0 in) laterally from roof side rail to roof side rail and longitudinally 457 cm (180 in) from the leading edge of the hood rearward to the backlight header. The maximum vertical and lateral crush was located at the junction of the left A-pillar and the windshield header. The maximum vertical crush measured 11 cm (4.3 in). The maximum lateral crush measured 4 cm (1.6 in).

All four door hinges were intact and remained attached to their respective pillars. The four latches remained engaged post-crash, and the front left, front right, rear right and back hatch were operational post-crash. The rear left door remained closed during the crash and was opened post-crash. Body deformation prevented it from closing post-crash. The damage sustained by the Chrysler in the rollover is depicted in **Figures 4 and 5**. The Collision Deformation Classification (CDC) assigned for the rollover event was 00TDDO3.

The impact to the rear of the undercarriage from the contact with the wood stop sign post resulted in minimal damage to the rear aspect of the undercarriage. The CDC assigned for this impact was 00UBDN1.

Figure 4: Overhead view of the rollover damage.

Figure 5: Frontal view of the rollover damage.

Interior

The Chrysler sustained moderate severity interior damage that was attributed to passenger compartment intrusion, occupant contact and air bag deployment. There was a scuff mark with blood and hair present located at the junction of the windshield header and the left A-pillar. This contact measured 7 cm (2.8 in) in length and 6 cm (2.4 in) in height. There was smeared body fluid on the headliner above the front left seating position located 13-30 cm (5.1-11.8 in) right of the left roof side rail and 30-49 cm (11.8-19.3 in) aft of the windshield header. There were droplets of blood on the headliner over the front center and right positions, with some droplets extending into the second row. The intrusion to the Chrysler is listed on the following table:

Position	Component	Direction	Magnitude
Row 1 Left	Windshield header	Vertical	10 cm (3.9 in)
Row 1 Left	Roof	Vertical	10 cm (3.9 in)
Row 1 Left	Roof side rail	Vertical	10 cm (3.9 in)
Row 1 Left	A-pillar	Vertical	10 cm (3.9 in)
Row 1 Left	B-pillar	Lateral	5 cm (2 in)
Row 1 Center	Windshield header	Vertical	7 cm (2.8 in)`
Row 1 Center	Roof	Vertical	7 cm (2.8 in)
Row 2 Left	Roof side rail	Vertical	6 cm (2.4 in)
Row 2 Left	Roof	Vertical	7 cm (2.8 in)
Row 2 Center	Roof	Vertical	4 cm (1.6 in)

The lateral intrusion to the B-pillar resulted in the B-pillar contacting, but not compressing the left side of the front left seat back.

Manual Restraint Systems

The Chrysler was equipped with 3-point manual lap and shoulder belts for the eight designated seating positions. All belt systems utilized continuous loop webbing. The front left belt system utilized a sliding latch plate and a retractor mounted pretensioner, which actuated during the crash. The front left upper D-ring was height adjustable and was in the full-up position. The driver's belt retracted onto and Emergency Locking Retractor (ELR). The driver was using the safety belt at the time of the crash, which was supported by loading evidence and body fluid on the belt webbing. This evidence consisted of a frictional abrasion attributed to the latch plate and body fluid. Specifically,

the latch plate abrasion was 5 cm (2 in) in length and was located 63-68 cm (24.8-26.8 in) above the floor anchor. The body fluid was located 67-121 cm (26.4-47.6 in) above the floor anchor. Additionally, the actuated retractor pretensioner locked the safety belt in the used position. The total length of spooled out and locked webbing was 149 cm (58.7 in).

The front right, second row outboard and all third row belt systems utilized ELR retractors and lightweight locking latch plates. The second row center utilized a switchable ELR/Automatic locking retractor (ALR) and a sliding latch plate. The second row outboard belt systems also contained height adjustable D-rings in the full-up position. In addition, the front right belt system utilized height adjustable D-ring in the full-up position and a retractor pretensioner which actuated during the crash, pulling the belt taut against the B-pillar.

Frontal Air Bag System

The Chrysler was equipped with a CAC frontal air bag system. The manufacturer of the Chrysler has certified that the vehicle is compliant to the advanced air bag portion of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The CAC system includes dual-stage frontal air bags for the driver and front right passenger positions, seat track positioning sensors, retractor pretensioners, a front right occupant presence sensor, and safety belt buckle switch sensors. The driver's air bag was concealed within the center hub of the four-spoke steering wheel. The front right passenger's air bag was concealed within the top aspect of the right instrument panel. The frontal air bags did not deploy in this crash.

Side Impact/Rollover Air Bag System

The Chrysler was equipped with roof side rail-mounted side impact IC air bags with rollover sensing. Both IC air bags deployed during the rollover event.

The IC air bags deployed from their respective roof side rails. The air bags measured 235 cm (92.5 in) in length. At the front and second row seating positions, the IC was 51 cm (20.1 in) in height. At the third row seating positions, the IC was 50 cm (19.7 in) in height. The IC extended 8 cm (3.1 in) below the belt line in the front and second rows, and 10 cm (3.9 in) below the belt line in the third row. At the front of each IC was a non-inflating triangular sail panel that measured 40 cm (15.7 in) in height, 28 cm (11 in) along the upper aspect and 32 cm (12.6 in) along the lower aspect. The sail panel was tethered to the A-pillar by a 14 cm (5.5 in) webbing strap. The IC's were tethered to the D-pillars by a 7 cm (2.8 in) webbing strap and began coverage 9 cm (3.5 in) forward of the D-pillars. The IC's provided longitudinal coverage from 9 cm (3.5 in) forward of the D-pillars to the A-pillars, and coverage from the roof side rail to the belt line.

There was smeared blood transfer on the inboard side of the left IC, covering the sail panel and the IC from the upper to the lower aspect and from the front of the IC extending rear 44 cm (17.3 in). There were droplets of blood on the inboard side of the right IC, in the front row. Neither IC was damaged in the crash. The right IC was labeled with the nomenclature: 28038450

Figures 6 and 7 depict the IC air bags in the Chrysler.

Figure 6: Left IC adjacent to driver's seat.

Figure 7: Right IC.

Air Bag Control Module

The 2007 Chrysler Aspen was equipped with an Air bag Control Module (ACM) that had EDR capabilities. An attempt was made to image the ACM by applying power to the vehicle and reading the data through the DLC port under the left instrument panel using the Bosch crash data Retrieval tool. The system in the Chrysler only records data in frontal crash events; therefore there were no recorded events for this crash.

Driver Demographics/Data

Driver Age/Sex:	26-year-old/Female
Height:	Unknown
Weight:	Unknown
Eyewear:	Unknown
Seat Track Position:	Mid track, 8 cm (3.1 in) forward of full-rear
Manual Safety Belt Use:	Lap and shoulder belt
Usage Source:	Vehicle Inspection
Egress from Vehicle:	Unknown
Mode of Transport from Scene:	Ground ambulance
Type of Medical Treatment:	Transported to a regional hospital where her admission status is unknown

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Unknown incapacitating injuries	Unknown	Unknown

Source = Police Report

Driver Kinematics

The 26-year-old female driver of the Chrysler was seated in a mid-track position and was restrained by the manual 3-point lap and shoulder belt system. The Chrysler departed the

roadway to the right and traveled in a tracking attitude for 105 m (345 ft). Prior to the rollover, the Chrysler entered a CCW yaw and the right tires and wheels furrowed into the soft soil of the grass roadside.

The yaw of the vehicle and the furrowing of the right wheels caused the driver to initiate a right and slightly forward trajectory within the front left seating position. The driver loaded the safety belt with her chest and abdomen as the ELR retractor locked the belt system. The driver also loaded the center console with the right side of her abdomen. When the Chrysler tripped into the right side leading rollover, the rollover sensor actuated the front safety belt pretensioners and removed 5 cm (2 in) of slack from the belt webbing and deployment the IC air bags.

As the Chrysler rolled to the right, the driver remained in a slightly forward posture. The left side of her head contacted the left A-pillar and roof side rail as they intruded laterally and vertically towards the driver. The driver initiated a rebound trajectory to the right within the front left seating position, causing droplets of blood to be deposited on the right IC and the headliner over the front center and right seating positions. The driver was restrained by the safety belt within the front left seating position.

After the vehicle came to final rest on its wheels, the driver came to rest in the front left seating position, restrained by the safety belt. The driver was transported by ground ambulance to a regional hospital.

Rear Center Occupant Demographics/Data

Occupant Age/Sex:	10-month-old/Male
Height:	Unknown
Weight:	Unknown
Eyewear:	Unknown
Seat Track Position:	Not adjustable
Manual Safety Belt Use:	Restrained in a rear-facing CRS that was secured to the vehicle by the 3-point lap and shoulder belt.
Usage Source:	Vehicle Inspection/police report
Egress from Vehicle:	Unknown
Mode of Transport from Scene:	Ground ambulance
Type of Medical Treatment:	Transported to a regional hospital, admittance status is unknown

Center Rear Occupant Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Unknown injury	Unknown	Unknown

Source = Police Report

Center Rear Occupant Kinematics

The 10-month-old child passenger was restrained in an unknown make/model rear-facing CRS that was installed in the rear center position of the Chrysler. The CRS was secured

to the vehicle by the manual 3-point lap and shoulder belt system. The CRS was not with the vehicle at the time of the SCI inspection and the driver could not be located to conduct and interview, therefore the specifics regarding the CRS and its installation are unknown. The child remained secure within the CRS by the integral harness system and sustained police reported possible injures. The child's specific injuries and subsequent medical treatment are unknown.

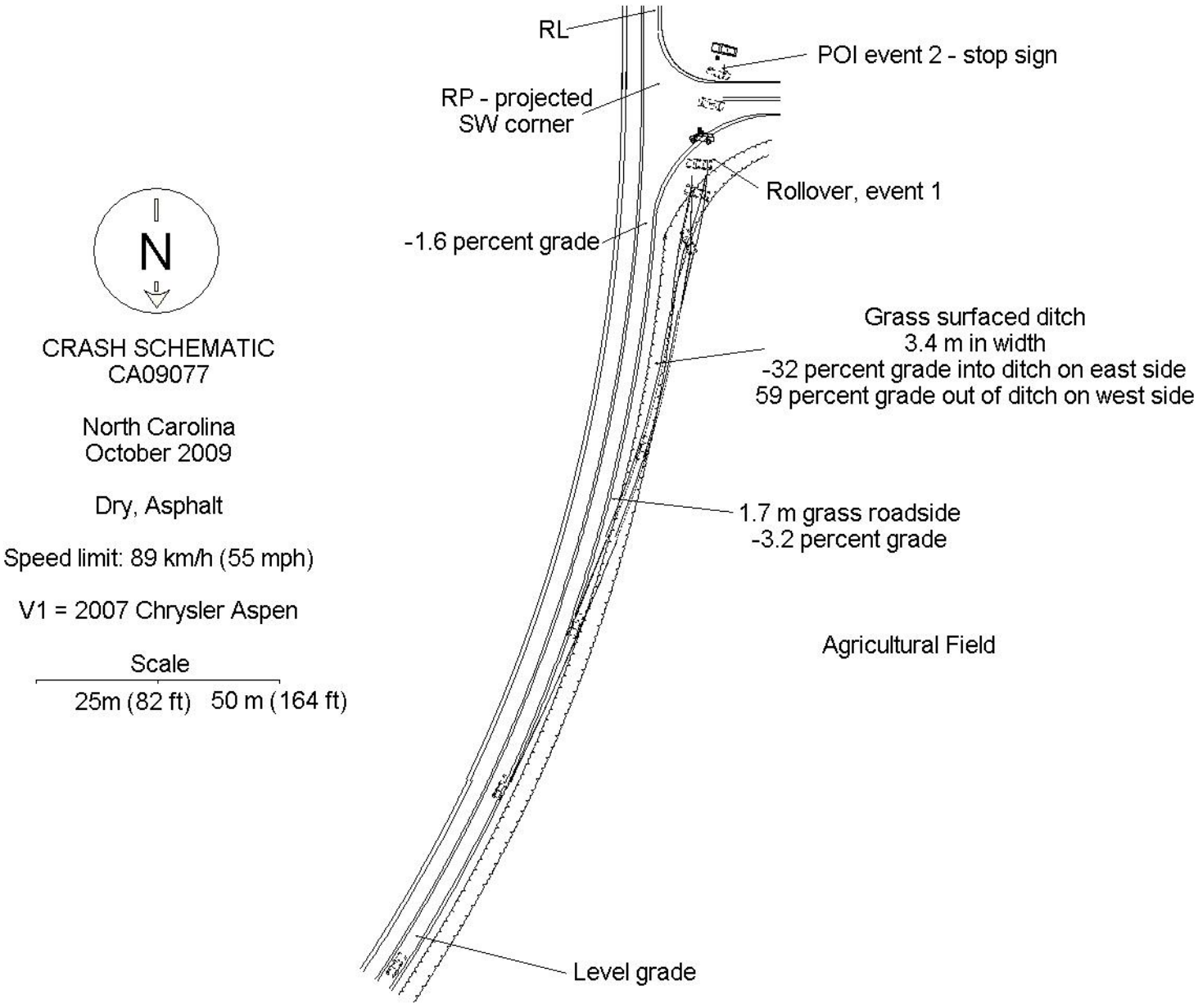

Figure 8: Crash Schematic

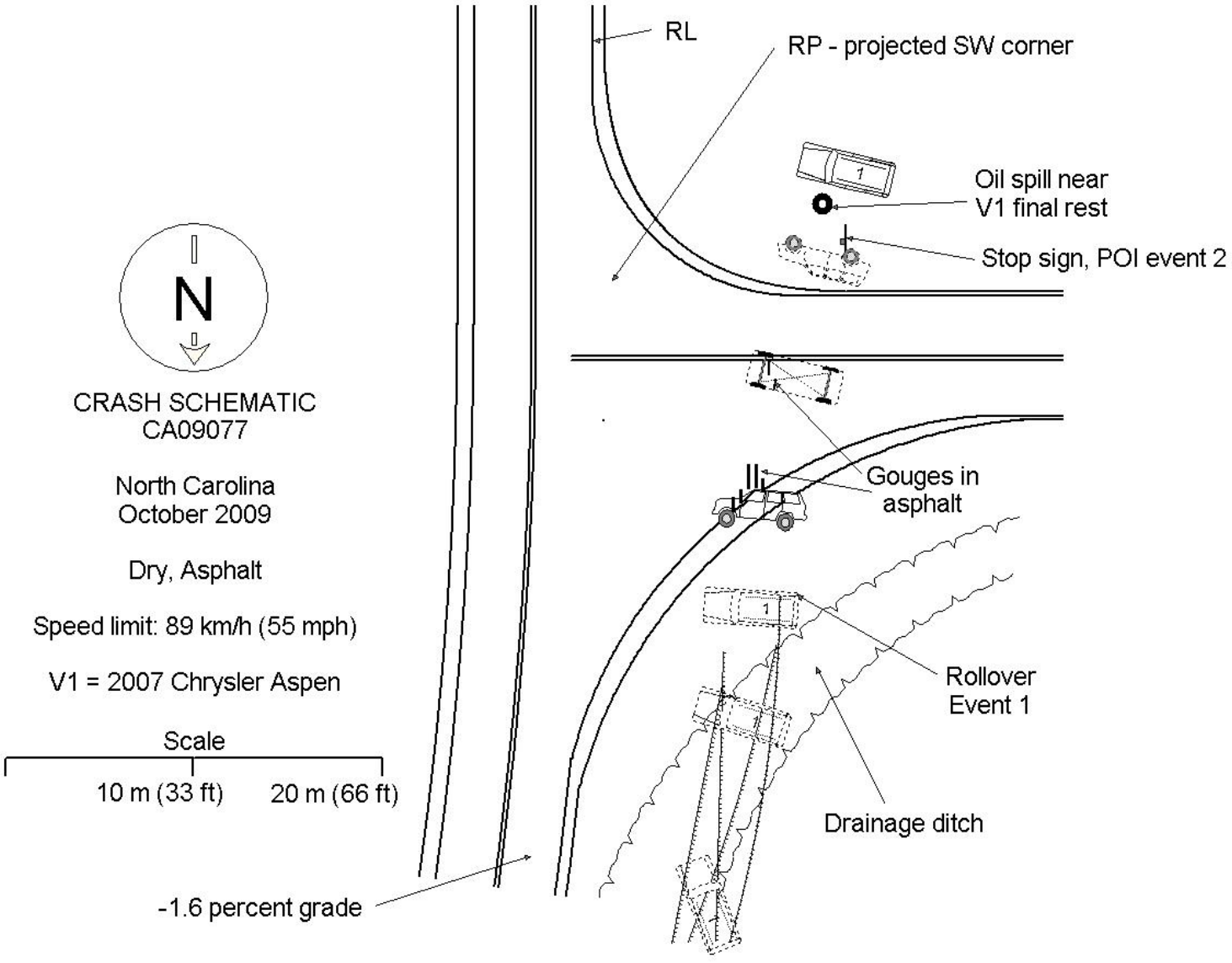

Figure 9: Enlarged area near rollover location.